A Study of Preferred Information Processing Style and its Relationship to Gender and Achievement in the Context of Design and Technology Project Work

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Introduction

One way of raising the efficiency of a scholar's learning and achievement is to improve teaching strategies employed by staff and the learning strategies adopted by the learner. Teachers have long recognised that learners differ in how they learn and interact with the teaching materials provided for them. However, as Riding (2002) explained, teachers have often lacked a clear means of knowing what these differences were and thereby take account of such differences in their teaching. The research reported in this article attempts to illustrate two of these differences: namely preferred information processing style and gender, and their relationship to achievement in the context of design and technology project work across two phases of education. A small-scale study involving three separate cohorts was used for data collection purposes. Cohort A was made up of 54 students from a university in the North East of England. These students were studying to become secondary school teachers of design and technology. Cohort B was made up of 63 students from a university in the Midlands. In this instance these students were studying to become industrial product designers. Cohort C was made up of 50 Year 10 pupils. These pupils were studying for their GCSE design and technology examination. Data concerning, preferred information processing style, gender and achievement were analysed and the relationship between the selected variables was discussed. Conclusions pertinent to this study were then drawn in the hope that teaching and learning strategies could be improved and that teachers in other institutions may be able to extrapolate from the findings to suit their own situations.

Background

Design and Technology Project Work

The design activity carried out by the scholars in each cohort in this study was very similar, although the actual design tasks varied between and within the cohorts of scholars. The aims of these activities were to extend the scholars' thinking processes, independence and self-motivation; whilst developing and expanding their ability to appropriately use research techniques, combine technical and aesthetic creativity, be sensitive to user needs, communicate their thoughts and ideas in appropriate two- and three-dimensional forms throughout the process, have an understanding, and skill in manufacturing and be able to evaluate both their product and their process (both design and manufacturing) in a manner that would enable them to design and make more effectively and efficiently in the future. The general criteria used to judge the success of the work were very similar for both school pupils and university students although a greater depth of knowledge, reflection and analysis and therefore a more insightful, complete solution to the design problem set was expected from a university student than was expected from a GCSE pupil.

Preferred Information Processing Style

Learning theories and practices have evolved over many years to reflect changes in society (Ali, 2003). How people prefer to learn and process information has become more important as learners have been provided with more and more opportunities to explore, discover and construct knowledge that was relevant, applicable, and useful to them instead of passively receiving information from teachers. Within a learning environment it is accepted that an enhanced understanding of learning theories may allow both scholar and teacher to understand why they and others do better in certain situations and with certain approaches. There is no doubt that over the past sixty years research in this area has received significant scholarly attention (e.g. Biggs & Moore, 1993; Craik & Lockhart, 1972; Curry, 1983; Entwistle, 1979; Riding & Cheema, 1991; Riding & Rayner, 1998). This research has been very diverse but generally addressed individual differences in the manner or form of psychological functioning. Defining the key terms associated with this area has not been a straightforward task. In particular, the terms

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learning styles, cognitive styles and learning strategies have frequently been used imprecisely or interchangeably in theoretical and empirical accounts of the topic (Cassidy, 2003), although a number of attempts have been made to organise the diverse research into more coherent frameworks (e.g. Curry, 1983, Riding & Rayner, 1998, Cassidy, 2003). In terms of definitions, there is now broad agreement that cognitive styles concern the ways in which different individuals characteristically approach different cognitive tasks (e.g. Hartley, 1998) and focuses on preferred ways of organising and processing information (Messick, 1996); and that learning styles concern the ways in which individuals characteristically approach different learning tasks (Boyle, MacDonald, Aked, Main & Dunleavy, 2003). A third key term in this topic is learning strategies which Hartley (1998), Price (2004) and others define as strategies that scholars adopt when studying.

Cassidy (2003) and others (e.g. Schmeck, 1988; Witkin & Goodenough, 1981) explained that cognitive style could be regarded as one significant component of learning style. They also suggested that learning styles were relatively consistent predispositions and more automatic than learning strategies, which they believed were optional and could be developed by the scholar where their style did not naturally fit the task being carried out. Messick (1987) and Squires (1981) viewed learning styles as strategies that could be attuned to particular types of task and situations. Riding and Cheema (1991) argued that although most individuals could and did switch strategies according to the task and context, many of them were consistently seen to be heavily dependant upon one or other style.

As the relevant research base into learning theories and practices has grown, the concept of cognitive style as being immutable, unchangeable and omnipresent has begun to be questioned (Armstrong, 2002; Evans, 2003; Roberts, 2001). There has also been recent debate into the stability and internal consistency of many of the instruments being used to label learners (Coffield, Mosely, Ecclestone & Hall, 2004; Peterson, Deary, & Austin, 2003; Riding, 2003) and a belief that the use of style labels has provided an incomplete, individualised and decontextualised view of learners. Although there has continued to be general acceptance that firstly, the manner in which individuals choose to, or are inclined to, approach a learning situation and process the information given were measurable (Gorham, 1986; Moran, 1991) and secondly, that a chosen approach could have an impact upon achievement (Cassidy, 2003).

Careful consideration of a number of available tests led to the use of a simple, short, computer based test: the Cognitive Style Analysis (CSA). This test was designed and developed by Riding (1991) to classify learners according to their position on two bipolar dimensions: the Wholist-Analytic (WA) and Verbaliser-Imager (VI) dimensions. These two styles or dimensions have proved to be independent of each other in many studies, in that the position of an individual on one scale does not influence their position on the other. Riding and others (e.g. Riding & Sadler-Smith, 1992; Douglas & Riding, 1993; Riding & Watts, 1997; Riding & Rayner, 1998; Riding, 2002) have also provided extensive research to relate WAVI cognitive styles to learning processes and more importantly in the context of this study, to information processing preferences.

The choice of Riding's CSA above other tests, as a means of categorising the scholars in this study in terms of preferred information processing style (PIPS), can be further understood when the skills required during design activity are mapped against the skills assessed by the CSA (see Figure 1). In Riding's test, the WA dimension describes whether individuals process information in wholes or in parts, it is suggested that Wholists tend to see the whole of a picture and appreciate the whole of the context in one go, however they have difficulty in appreciating the parts. Analytics at the opposite end of the same dimension are capable of seeing the details of a situation, but may have difficulty in appreciating how parts relate to one another. In the CSA test, the VI

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dimension classifies whether individuals represent information during thinking in words or images. Verbalisers tend to organise thinking as associations of words, whereas Imagers tend to handle mental information in the form of images. Riding also relates the focus of Verbalisers and Imagers' activity as internal for Imagers and external for Verbalisers (Riding, 1991). The relationship between this terminology and that used to describe

designing can be easily accepted when one refers to the manipulation of images as central to the activity, the need to examine thinking verbally, and the requirement to see the problem holistically at times whilst at others being able to concentrate on the detail of individual components, and that these skills are all expected of the designer whether in school or in a university environment.

	Wholist	Analytic
CSA	Processes information in wholes	Processes information in parts
	Sees whole, difficult to see parts	Sees details, difficult to relate parts to one another
Designing	Holistic approach to the process	Targets one aspect in order to work out details
	Deals in whole ideas	Builds up solutions from parts

	Imager	Verbaliser
CSA	Processes information in images	Processes information in words
Designing	Produces images of thinking	Annotates to examine thinking or help describe ideas

Figure 1. Illustrates the two dimensions of CSA mapped against design activity

Achievement

The educational theorist would hope that the fundamental purpose of assessment is to give feedback to both learners and staff. It should provide information that will enable teachers to improve their teaching strategies and materials and thereby enrich the learning experience of those being taught. It is also the case that the assessment used to judge success should not dictate curriculum content (Task Group on Assessment and Testing, 1987). Rather it should be designed to develop capability and competence. However, the nature of assessment and its criteria has been shown to influence what is learnt, how it is learnt and how it is taught (Atkinson, 1997; Atkinson, 2003). In the past the culture and traditions of both schools and universities have been deeply rooted in enriching learning. However, recently there have been indications that the purpose of assessment has changed. Factors such as government interventions; the requirement for accountability to the individual learner, the institution and the government; and clarity in the relationship between learning objectives,

learning outcomes, and assessment criteria have all led to the development of a predominantly categorising assessment culture within many schools and universities. In the university situation, the massive increase in the number of students entering higher education, the change in the character and needs of the student population, and the worsening staff-student ratios have also had an effect upon what is learnt, how it is learnt and what is assessed.

There are also other key factors that impinge upon achievement. These have been shown to fall into two categories: those that are scholar dependant and those that are teacher dependant (Weiner, 1992). In the case of the scholar studying design and technology, such factors as intellectual ability, creative ability, level of motivation, and learning and information processing style can all affect levels of achievement. In the case of factors that are teacher/lecturer dependent there are the scholar's appropriate knowledge and skills capability, the instruction given regarding the design process to be implemented, the

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relationship between the knowledge base and the process used, the balance of time provided for the project and the teaching strategies adopted. This picture is made even more complex when one considers that these factors can all be further divided into those that are internal or external, stable or unstable, controllable or uncontrollable (Weiner, 1992). So to isolate information-processing style as being the factor that affects achievement would be unwise, although this research project hopes to provide more information and clarity regarding the important relationship between the two.

Gender
Equal opportunities within an educational context continue to concern educationalists, the government and others, in spite of much research (e.g. Gilligan, 1982; Kelly, 1999; NCC, 1989), the introduction of equal opportunities legislation (Harding & Grant, 1984) and many government-sponsored initiatives, particularly in science and technology (e.g. Kelly et al, 1981). As one of the facets of equal opportunities gender issues have been a growing concern, especially since gender has been shown to be a strong determinant of performance across many subjects and at each phase of education.

In design and technology, gender differences have been researched in terms of motivation (Kimbell et al, 1991; Riggs, 1993), interests (Kimbell et al, 1991) and the perception of learners (Riggs, 1993), as well as a teacher's willingness or otherwise to tackle any sex-role stereotyping (Riggs, 1993) and a need to link the subject with social values (Gilligan, 1982; Riggs, 1993; Smail, 1984). The problems associated with gender imbalance (Riggs, 1993) both in terms of opportunity (Bryne, 1978; Harding & Grant, 1984) and achievement (e.g. Atkinson, 1995; 1998; 2000; 2004; Banks, 2002; Harding, 2002; Kimbell et al, 1991) have also been well documented.

There has also been interest recently in the theory that gender should be considered flexible and multi-positional rather than an either/or situation and that this is particularly

so in a learning situation where biological gender classification may be flawed. Research suggests that there are biologically female learners who exhibit typical female learner characteristics and there are those who exhibit male learner characteristics and in the case of male learners there are those who exhibit typical male learner characteristics and those who exhibit female learner characteristics. In other words, individuals as learners should be placed on a continuum rather than be classified as either one or the other. However, establishing where each learner could be placed on such a continuum was not addressed during this study mainly because a valid, reliable test for establishing this form of gender categorisation does not exist, nor do researchers of gender issues believe that such a test would be appropriate. It is also the author's belief that such a distinction would only become an issue if the data indicated that there were no gender differences using biological gender categories and in this case further clarification would have been helpful.

Method
Sample
A total sample of 167 scholars was used in this study. The sample was made up of three separate cohorts, all of whom were studying D&T to examination level.

Cohort A was made up of 54 students (25 male, 27 female) from a university in the North East of England. These students were studying to become secondary school design and technology teachers. The average age of the cohort was 28.69 with a maximum age of 54 and a minimum age of 19. The entry qualifications of these students varied between: Access to Higher Education, HND's and a small number with A' Levels.

Cohort B was made up of 63 students (48 male, 14 female) from a university in the Midlands. In this instance these students were studying to become industrial product designers. The average age of this cohort was significantly less than Cohort A. It was 18.7, with a maximum age of 21 and a minimum age of 18.

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All these students had entered university with a minimum of three A' Levels.

Cohort C was made up of 50 Year 10 pupils (36 males, 14 females). These pupils were studying for their GCSE design and technology examination and were taken from eight mixed ability classes in eight separate schools in the North East of England (see Atkinson, 2000: 262, for further details of the methodology used in the selection of this sample).

Instrumentation
The following materials were used in the data analysis of this study.

Preferred Information Processing Style (PIPS): as discussed in the background section of this article, a well-established test (CSA; Riding, 1991), which was computer presented and self-administered was chosen to establish the PIPS of the sample. The test indicated a person's position on both the Wholist-Analytic and the Verbal-Imagery dimensions of PIPS by means of an independent ratio for each (Riding and Rayner, 1998). Each member of the total sample carried out the CSA in the manner prescribed in the CSA administration documentation (Riding, 2000).

Gender: The biological gender of the each member of the sample was collected as an integral part of the CSA test.

Achievement: One post-design and technology project result was used from each scholar in each cohort. In the case of Cohort A and B it was the mark achieved by each student for his/her design and make project carried out as a culmination of a year's university study. In both cases these marks had been cross-moderated internally to meet stringent university guidelines. In the case of Cohort C it was the mark achieved by each pupil for his/her GCSE design and technology coursework project. This mark had been awarded by the school and moderated externally by officers from the examination board.

Data analysis
The data were analysed using StatView software. This allowed raw scores to be entered and used in analyses for measures of central tendency, standard deviation, percentages, Chi-square tests for variance and box plots.

Preferred Information Processing Style Data - Outliers
When using the mean of any data, each observation plays a part in the calculation of that mean, so difficulties can arise if the data contains outliers, observations that are distant from the bulk of the data (Robson, 1993;Statview, 1999). Most statistical procedures are very sensitive to the presence of outliers and therefore statisticians tend to discard them. However, if the data has been thoroughly checked and it is correctly entered, it can provide important information that should not be ignored (e.g. Clegg, 1990; Robson, 1993). In the case of this study outliers were considered vitally important, particularly in terms of the PIPS data, for these outliers were extreme Wholists or extreme Analytics on the WA dimension, and extreme Imagers or extreme Verbalisers on the VI dimension. With data for these extremes it was possible to determine whether people who were extreme in any PIPS category were more or less able to achieve high scores in design and technology project work than those nearer the centre of a dimension. Therefore where appropriate the results for outliers have been reported and discussed.

Gender data
The author was aware that any gender imbalance in terms of numbers of males and females between and within cohorts must be borne in mind when gender distribution was used as a variable in any analysis. Also, as discussed earlier, the gender data collected was biological gender and that in a learning environment this might prove problematic.

Achievement data
The design briefs that each member of the total sample tackled were not all similar in context or content and therefore did not necessarily enable

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each scholar to use the same balance of information processing skills or adopt the same design process model. Nor were the marks awarded to each scholar moderated across cohorts. Therefore it was deemed inappropriate to compare actual marks awarded across the three cohorts. However, by converting the percentage marks for each member of the sample into a rank order position within a cohort it was possible to compare how successful a scholar had been in relation to the rest of his/her cohort and across cohorts. To achieve the rank order positions, the raw percentage marks awarded to each member of each cohort were put into rank order, cohort by cohort. These four rank order lists were then each split into four equal quartiles with a score of 4 being given to all those in a top quartile, a score of 3 to those in a second top quartile, a score of 2 to those in a second bottom quartile and a score of 1 to those in a bottom quartile. The overall mean rank order (RO) score for the total sample was 2.476. This was very close to the expected mean of 2.5. The slight difference being caused when more than one member of a sample achieved an identical mark at the boundaries between quartiles. The mean RO scores for each cohort (Cohort A 2.455; Cohort B 2.492; Cohort C 2.480) were then found to be similar and it was therefore deemed possible to use this data when comparing achievement in the form of rank order groups across cohorts.

Results and discussion
The preferred information processing style of the sample
Each member of the sample was allocated to a PIPS category using the data from the CSA test and the CSA administration documentation. There were differences between the numbers of scholars in each PIPS category whether viewed as a total sample or as individual sub-samples when the data were analysed using the two PIPS dimensions separately (See Table 1). In a comparison to the CSA standardisation sample (n = 999) referred to by Riding (2000) two out of the three cohorts reported in this study (Cohort A & C) failed to replicate his findings where there had been an even spread between each PIPS category. This was expected in the case of the university samples as these students had chosen to study for a degree that required a specific range of information processing skills that were possibly possessed by people with certain preferred information processing styles. In Cohort B, one of the university samples, surprisingly the cohort did conform to the standardisation sample.

In the case of the school sample (Cohort C) the PIPS data did not follow the even distribution pattern of the standardisation sample (Riding 2000) nor did it replicate the findings of Riding et al (1995) in a research project that used 12 year old pupils (n = 380) where once again there was an even spread in each PIPS category. As pupils in Cohort C had been taken from mixed ability classes with no specific subject bias, findings in this study were not as expected. In trying to ascertain a reason for this difference the author would suggest that maybe the small sample size in this study (n = 50) may have affected these results and therefore care needed to be taken when coming to conclusions using this data.

PIPS category	Cohort A		Cohort B		Cohort C		Total	
Wholist	18*	33%	31	49%	19*	38%	68	41%
Analytic	36*	67%	32	51%	31*	62%	99	59%
Verbaliser	19*	35%	36	57%	23	46%	78	47%
Imager	35*	65%	27	43%	27	54%	89	53%
* significant difference p = < .0001								

Table I. Illustrates the PIPS of the total sample with the data from each dimension indicated separately and by cohort.

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On the WA dimension where there was the greatest difference between the two PIPS categories within the total sample, there was a larger number of Analytics than Wholists in each cohort and the difference was significant in both Cohorts A and C.   On the VI dimension there were a larger number of Imagers than Verbalisers in the total sample although the difference was only 6%. When viewed by cohort, a difference was noticeable in Cohort A, one of the university samples, where 65% were Imagers. However in Cohort B, the other University sample there was a greater number of Verbalisers than Imagers (see Table I).

This later result was surprising, as it had been anticipated that there would be a larger number of Imagers than Verbalisers, similar or even greater than that found in Cohort A where the students were training to be teachers, albeit of design and technology. Cohort B as explained earlier were also not a random sample, they were training to become industrial product designers where an ability to represent and manipulate images in one's mind has always been considered an important skill in the development of creative, innovative functional products, whether more artistic or technological in nature (e.g. Potter, 1989). In trying to tease out a reason for this result the author wondered if although the literature had suggested that PIPS and intelligence were mainly independent of one another (Riding & Pearson, 1994; Riding & Agrell, 1997; Riding & Rayner, 1998), that the information processing characteristics associated with Verbalisers had enabled these particular students to do well in their A' Level examinations across a variety of subjects and thereby gain a place at this university where high A' Level scores were a necessity for entry to the course. Or maybe the technical nature of the design tasks set as part of the course, where a Verbaliser's ability to deal with abstract, semantic complexity (Riding & Rayner, 1998) was required, had attracted those who were Verbalisers. How well these Verbalisers then did in their design activity, in comparison to Imagers, will be discussed in the achievement section of this article.

PIPS Combined Category	Cohort A		Cohort B		Cohort C		Total	
WV	04*	7%	20*	32%	08*	16%	32	19%
WI	14	26%	11	18%	11	22%	36	22%
AV	15	28%	16	25%	15	30%	46	28%
AI	21**	39%	16**	25%	16	32%	53	32%
Totals	54	100%	63	100%	50	100%	167	100%

* & ** significant differences p = < .0001

Table 2. Illustrates the number and percent of the sample in each PIPS category divided by cohort.

Analysis of the PIPS data when the two dimensions were combined indicated that there were significant differences between certain cohorts and similarities between others (see Table 2). The rank order in terms of percentage of each cohort in the combined PIPS categories for Cohort A and C were identical. The largest number of scholars was to be found in the AI category, followed by AVs then WIs and the least were found in the WV category. In contrast there were significantly more WVs in Cohort B and it was in the WI category where the smallest proportion of students was found. As expected from a mixed ability group of school pupils who were studying across a wide spectrum of GCSE subjects the combined PIPS distribution was more evenly spread than in either of the two university cohorts.

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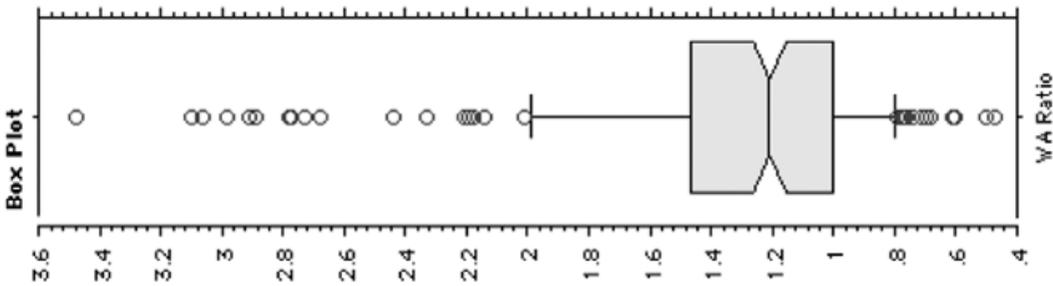

Figure 2. Illustrates the total sample PIPS ratio on both the WA and VI dimension including the outliers at the extremes of each end of each dimension.

As already discussed in the data analysis section of this article, the data indicating how many individuals in each cohort could be found at the extremes of each PIPS dimension was deemed important. In the first instance the outliers in terms of WA and VI ratios for the total sample were calculated in order to establish the number and percentage of the total sample at the extremes (see Figure 2). When this data were then divided by cohort an uneven number of outliers were found in each cohort (see Table 3). There were just less than 25% of school pupils (Cohort C) who were outliers. In the two university samples, Cohort B had a significantly larger number (54%) of outliers than were to be found in Cohort A (17%).

The data also indicated that there was no consistency between the three cohorts regarding which PIPS category had the highest percent of outliers. In the school pupils' sample it was in the WI PIPS category, in Cohort A part of the university sample it was in the WV PIPS category and in Cohort B it was in the AV category. The importance of this finding will once again need to be discussed in relation to achievement later in this article.

PIPS	Cohort A			Cohort B			Cohort C		
	total	Outliers	%	total	Outliers	%	total	Outliers	%
WV	6	2	33%	23	7	30%	08	2	25%
WI	14	0	0%	12	8	67%	11	5	46%
AV	13	3	23%	12	9	75%	15	1	7%
AI	21	4	19%	16	10	63%	16	4	25%

Table 3. Illustrates the number and percentage of the sample that were to be found at the extremes of each PIPS category split by cohort.

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Gender similarities and differences between the cohorts

Although there was found to be a considerable difference in the biological gender distribution of the sample in each cohort, this was expected. Cohort B and C had a significantly higher proportion of males to females (see Table 4). The gender difference in the school sample (Cohort C) was anticipated and matched the gender distribution that occurred across the total GCSE entry for the design and technology examination that year. The gender difference found in Cohort B, the university sample, where students were studying to become industrial product designers, was also expected as recruitment to higher education programmes of this nature have always tended to attract more males than females even though there have been various national initiatives to try to re-dress this gender imbalance over recent years.

The gender distribution in Cohort A, the other university sample, was also as expected. These students were training to become teachers and even though the subject they wished to teach tended to be male dominated, the trend over the past few years at the university in question has been towards a more even gender balance. Therefore to find a slightly higher number of females than males in this cohort was not a surprise.

Cohort	Male		Female		Chi Square Variance p -value
Cohort A	25	48%	27	52%	0.3136
Cohort B	48	77%	14	23%	< .0001 *
Cohort C	36	72%	14	28%	< .0001 *
* significant difference					

Table 4. Illustrates the biological gender differences between Cohorts A, B and C.

The breakdown of PIPS category by gender and cohort indicated some similarities and some differences (see Table 5). In terms of the WA dimension in Cohort A there were more Analytics than Wholists of both gender, although this was only significantly so in the case of the female sample. In Cohort B there was a mirror image, more males were Analytics, 56%, with only 35% of females being Analytics. In Cohort C 66% of males were Analytics whereas females were equally divided between Analytics and Wholists.

On the VI dimension in Cohort A, a similar, significantly high percentage of males (68%) and females (62%) were Imagers in comparison to Verbalisers. In Cohort B the difference between male and female Imagers and Verbalisers was not significant, although in this case there were more Verbalisers than Imagers in both gender categories. In Cohort C there was a gender mirror image. There were significantly more male Imagers than male Verbalisers and there were more female Verbalisers than female Imagers, although this was not by a significant amount.

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PIPS category	Cohort A		Cohort B		Cohort C	
	Male	Female	Male	Female	Male	Female
Analytic	15	20*	27	5	24	7
Wholist	10	7*	21	9	12	7
Imager	17*	17*	22	5	21	6
Verbaliser	8*	10*	26	9	15	8
* significant difference p = < .0001						

Table 5. Illustrates gender differences in terms of PIPS split by cohort.

With regard to outliners and gender, there were differences in terms of the proportion of male and female outliers in each cohort. There were twenty-four male outliers in Cohort B. This was half the total male sample for that cohort and a significantly higher proportion than was found in either of the other two cohorts, where there were seven male outliers in Cohort A and only six in Cohort C. Unfortunately the data collected did not provide an explanation for the results for Cohort B.

When the data concerning the number of female outliers in each sub-sample was scrutinised it was found that there were only four female outliers in each cohort. In the case of Cohort B and C this was nearly 15% of the total female sample in each cohort, whereas in Cohort A where there was a larger proportion of females overall there was a smaller proportion of those females who were outliers.

Achievement

In terms of achievement, when viewed by cohort there was no consistency between which preferred information processing style achieved top mean RO scores and which achieved bottom mean RO scores. In the school cohort it was Analytics at the top and Wholists at the bottom. Whereas in the two university cohorts it was the other PIPS dimension that filled these positions. In Cohort A it was Verbalisers who gained the highest mean RO score and Imagers the lowest and in Cohort B Imagers achieved the highest mean RO score whilst Verbalisers gained the lowest (see Table 5).

Although there was no overall consistency the data did indicate that Analytics did the best overall when data were scrutinised in the nine sets of results illustrated in Table VI. They came top in five of the analyses, Imagers came top in only two and Verbalisers and Wholists in only one each. This finding will be teased out further later in this section.

The effect of outliers upon data when dealing with mean scores has already been examined in the data analysis section and the importance of the data for those outliers were also explained. As can be seen from Table 6 the rank order of which PIPS category achieved the highest mean RO score in each cohort changed when the data was divided to compare outliers with the rest of the data.

In Cohort A, Verbalisers with a mean RO score of 2.526 were the most successful when the total data for that cohort was used, Wholists with a mean RO score of 2.667 were the most successful when the outliers were removed, although it was extreme Analytics who were the most successful with the highest mean RO score of 2.800 when the outliers were scrutinised on their own. In Cohort B, Imagers with a mean RO score of 2.593 were the most successful when the total data was used, Analytics with a lower mean RO score of 2.520 were the most successful when the outliers were removed and once again Imagers were the most successful with the highest mean RO score of 3.167 when the data for outliers was scrutinised on its own. In Cohort C, the school pupils, Analytics remained the most successful

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PIPS category in all three analyses with Wholists being the least successful in each case. This result indicated that in this educational setting the WA dimension was a more reliable determinant of achievement than whether a pupil was an Imager or a Verbaliser. Thus adding further evidence to support the concern raised in several studies regarding the lack of holistic approaches to design activity in schools (Layton, 1991; Atkinson, 2000).

Total Sample of CS		Sample without Outliers		Outliers	
Cohort A					
V	2.526	W	2.667	A	2.800
W	2.500	V	2.571	I	2.600
A	2.472	I	1.433	V	2.400
I	2.457	A	1.419	W	2.167
Cohort B					
I	2.593	A	2.520	I	3.167
W	2.516	V	2.483	W	3.000
A	2.469	I	2.429	A	2.286
V	2.417	W	2.375	V	2.143
Cohort C					
A	2.645	A	2.615	A	2.800
V	2.522	V	2.526	I	2.600
I	2.444	I	2.409	V	2.500
W	2.211	W	2.214	W	2.200

Table 6. Illustrates the mean RO scores for each PIPS category divided by cohort and placed in rank order.

The results of the analysis of the data in Table 6 provided other interesting statistics regarding PIPS outliers. In each cohort extreme Imagers achieved a higher mean RO score in their project work than middle of the road Imagers in that cohort. In fact in Cohort B extreme Imagers achieved the highest mean RO score of all outliers with a score of 3.167. This was particularly interesting, for as reported earlier in this article it had been anticipated that imagers would be the most successful set of students and yet significantly more Verbalisers had been recruited to study industrial product design in Cohort B, and the technical nature of the tasks set should have put these Verbalisers with the ability to deal with abstract, semantic complexity at an advantage, and yet these students had been the least successful.

The success of Imagers who were outliers in each cohort was not replicated in the other three PIPS categories. Extreme Analytics achieved a higher mean RO score than middle of the road Analytics in only two out of the three cohorts, failing to do so in Cohort B. Extreme Verbalisers and extreme Wholists only achieved a higher mean RO score on one occasion (Verbalisers in Cohort C and Wholists in Cohort B) in comparison to middle of the road Verbalisers and Wholists.

The results of the PIPS outlier analyses added further weight to the researcher's belief that imaging was crucial to successful design and technology project work whatever the nature or context of the task set as described in an earlier section of this article, and that being an extreme imager would seem to be an indicator of design potential in both school and university environments.

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Gender differences in attainment

	Cohort A		Cohort B		Cohort C	
	Male	Female	Male	Female	Male	Female
Mean RO Scores	2.280	2.536	2.562	2.143	2.306	2.929

Table 7. Illustrates the mean RO scores obtained by males and females in each of the three cohorts.

The greatest gender difference between the mean RO scores for males and females was found in Cohort C and the least difference was found in Cohort A (see Table 7). In both these instances the female mean RO score was higher than the male result. In the case of Cohort B there was a mirror image in the gender data. The mean RO score for males was higher than that for females, although one has to remember that the female cohort in Cohort B was significantly smaller than the male cohort (see Table 4) and that this may have affected this result.

Cog Style	Cohort A		Cohort B		Cohort C	
	Male	Female	Male	Female	Male	Female
Analytic	2.200	2.600	2.519	2.200	2.583	2.857
Wholist	2.400	2.571	2.619	2.111	1.750	3.000
Imager	2.353	2.471	2.818	1.600	2.190	3.333
Verbaliser	2.125	2.800	2.346	2.444	2.467	2.625

Table 8. Illustrates the gender mean RO scores of each cohort when split by PIPS categories and cohort.

When RO scores were scrutinised with the two dimensions of cognitive style and gender as the variables the data continued to show that the females in each cognitive style category outperformed their male counterparts in Cohort A and Cohort C although this was not by a statistically significant amount. The greatest gender difference was found amongst Cohort C Wholists, where the female mean RO score was 1.250 greater than the male score. It was also the case that female Imagers from Cohort C achieved the highest mean RO score (3.333) of any PIPS sub-sample whereas male Wholists from the same cohort achieved the lowest mean RO score (1.750) of any sub-sample. In this cohort of pupils this would seem to indicate that at GCSE level female Imagers were more likely to achieve high results and male Wholists achieve low results, although once again gender imbalance may have influenced the result.

When scrutinised cohort-by-cohort, female Verbalisers achieved the highest mean RO score in Cohort A, male Imagers achieved the highest mean RO score in Cohort B, and as already stated female Imagers achieved the highest mean RO score in Cohort C. In terms of gender success males in Cohort B continued to indicate a mirror image of the results of the other two cohorts. The scores for males in Cohort B were higher in three out of the four PIPS categories. The exception was in the Verbalisers data where female Verbalisers outperformed male Verbalisers although this was only by a very small amount (0.098).

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When the relationship between gender, outliers and achievement was examined it was found that male outliers in Cohort B achieved the highest mean RO score of males (2.710) with males in Cohort A (2.286) and C (2.250) achieving a lower but similar mean RO score to one another.   In Cohort A female outliers achieved a mean RO score of 3.000, which was a higher mean score than was achieved by any male outliers. In Cohort B female outliers only achieved a mean RO score of 2.250, this was the lowest mean RO score for any of the female outliers and was also lower than the male outliers in that cohort. In Cohort C female outliers achieved the highest mean RO score of all female outliers (3.750). This mean score was also much higher than any score achieved by male outliers. Unfortunately although the analyses continued to add to the picture of females in general outperforming males, at the extremes of each PIPS category the small size of each sample meant that statistical analysis could not be carried out on the data to indicate just how significant this might be.

Conclusion
The intention of this small-scale study investigating the relationship between preferred information processing style, gender and achievement in the context of design activity across two phases of education was not to be able to generalise the findings to a larger population, but that the results would add to the current picture and debate concerning the possible advantages of taking preferred information processing style into consideration when trying to improve the effectiveness of teaching strategies and the efficiency of a scholar's learning.

The outcomes of the research would seem to support the widely held belief that imaging is central to design activity and that having a strong preference for representing and processing information during thinking in images may well be an important determinant of achievement as well as facilitating the production of successful products, even though it is recognised that analytical, reflective, holistic thinking is crucial to the development

of such successful products. In the context of this study this was particularly noticeable for those scholars studying to become industrial product designers, where more Verbalisers than any other information processing style had been recruited to this programme. The lack of success of these Verbalisers added further evidence to the picture indicating that where the ability to produce solutions that would be at the cutting edge of industrial product development was paramount those who could produce their analytic, holistic and reflective thinking in the form of images rather than verbally were the most successful.   On the other hand, in the case of those training to become design and technology teachers, although there were significantly more Imagers than Verbalisers in the sample, it was Verbalisers who did well in their design activity. One interpretation of these differences could be that although the design activities of both sets of university students had similar educational aims as described earlier in this article, the teaching strategies adopted and the emphasis of the assessment regime used to judge success for the two cohorts was different. Those training to become teachers were expected to show more evidence of dealing with the individual parts of the process, and present more verbose reflective thinking about the process pertinent to someone who was going to teach others how to design, and that these factors may possibly have played into the hands of those who could more easily explain their thinking through the written word than those who used mainly images.

In the case of the school pupils in this study, being analytic turned out to be a more important determinant of achievement than any of the other preferred information processing styles. This provided further evidence to sustain the long held belief that assessment criteria at GCSE remains too concerned with the individual sub-activities associated with the process than is acceptable (Layton, 1991; Atkinson, 2000).

In terms of gender issues raised, the results indicated that gender was a determinant of

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achievement in the context of design activity, although which gender had more success was dependent on the learning situation under investigation. Females outperformed males in two out of the three cohorts, no matter whether the data was viewed as a total cohort or whether those at the extremes of preferred information processing style were scrutinised separately. One of these cohorts contained the GCSE pupils which supported the existing evidence to suggest that females benefit more than males from the format and expectations of coursework during this stage of education. The cohort that did not follow the successful female trend contained the students studying to become industrial product designers. In this instance there was a much larger cohort of male students than female students and they outperformed their female counterparts in each analysis. Unfortunately the limited breadth of variables used in this study could not provide evidence to explain this result although the nature of the task set which had been orientated towards the harder technologies rather than being concerned with social values which have been shown to favour female design and technologists may have had some effect upon these results.

Finally, the results from this study indicate that in both phases of education scholars need to strengthen their ability to process and represent information in forms that they do not naturally favour. Teachers need to recognise that design activity is an ideal context in which such skills can be developed as designing requires the skills of the imager, the verbal communicator, the holist and the analytic at various stages throughout the process. It would also appear that equal gender opportunities in terms of achievement and access remain problematic particularly for school pupils and those studying to become industrial product designers. Whereas in the context of students training to become teachers of design and technology, forms of assessment that reward a more holistic view of the design process as well as ones that redress the balance between the reward given to verbal communication that is easy to assess and the

use of images that do not always reflect the breadth and depth of critical thinking that has taken place in a transparent manner, must be developed. These changes are important, for if students that are training to become design and technology teachers are over-rewarded for design activity that uses a segmented approach that relies heavily on verbal communication then when they become design and technology teachers themselves they will encourage their pupils to favour this style of designing, especially if their pupils are over-rewarded for such activity too. In turn, these very pupils may become the industrial product design students of the future, where an inability to be flexible and ability to use information processing in the form of images to illustrate their thinking has been shown in this study to weaken their chances of high levels of success.

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